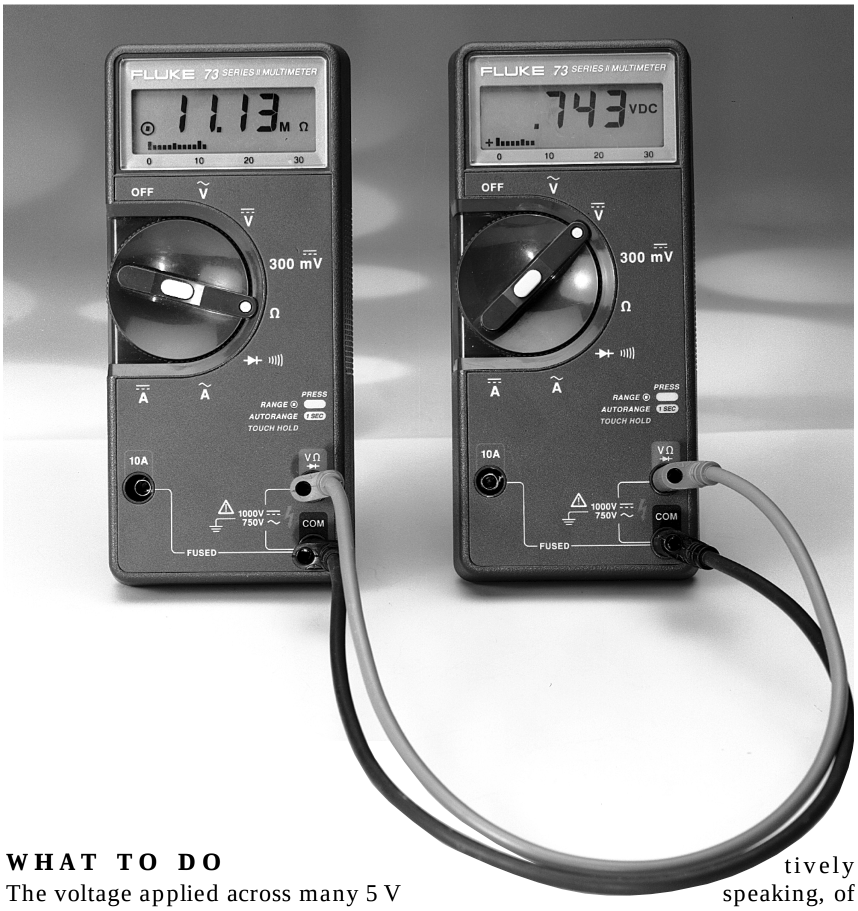
measurement oddities

faultfinding with an ohmmeter

Faultfinding with a multimeter set to measure resistance yields quite a lot of information, but is not without risks. This is because when the meter is set to this range, there is a potential across its terminals.



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INTRODUCTION

When a multimeter is set to a voltage or current range, it is a passive instrument that simply measures the potential across, or the current through, a component, line or network. Clearly, it has some effect on the component (or line or network), since in the first case it is shunted by a high-value resistance, and in the second case, a small resistance is coupled in series with it. In almost all cases, this effect is negligible, however.

When the meter is used to measure resistance or circuit continuity, it behaves as an active instrument, because for those purposes it needs to apply a voltage across the component (or line or network). It is this voltage that gives rise to concern, since sensitive, expensive components may be damaged by it, sometimes irreparably so.

WHAT TO DO

The voltage applied across many 5 V integrated circuits must not exceed 6.5 V, while modern 3.3 V integrated circuits are even more sensitive. It is, therefore, necessary to know the level of voltage across the meter terminals when this is set to the resistance range.

This is easily established with the aid of a second multimeter. Link the test leads of the two instruments in parallel, set one meter to a resistance range and the other to a (low) direct voltage range. The second meter then reads the test voltage provided by the first.

It is essential to carry out this measurement on all resistance ranges. This is because many multimeters have several resistance ranges as well as a diode/continuity test range and the test voltages in these ranges can differ appreciably from each other. The test voltage is often particularly high (relatively speaking, of course) in the diode/continuity range: usually well above the diode voltage (forward bias) of 700 mV (in case of a silicon diode).

Inspection of various multimeters shows that the test voltage can vary from about 300 mV to as much as 4.5 V.

It is rather more difficult to determine the test voltage of meters with an autoranging facility. This is because when a voltmeter is connected to one of these types, it detects a high resistance and switches automatically to the MΩ range. To ascertain the test voltage in the other resistances ranges, a number of resistors, say, 100 Ω, 1 kΩ, 10 kΩ, and 100 kΩ are needed to shunt the voltmeter terminals.

MEASURING

It may be assumed that when the test

voltage is not higher than 300 mV, any component, line or circuit can be tested without any risks. If the test voltage lies between 700 mV and 2 V, the same applies, but it should then be borne in mind that diodes, transistors, and ICs in the network on test may come on and influence the measurement.

Test voltages higher than 2 V should not be used, because they affect the operation of the network on test. Some analogue meters, especially moving-coil instruments, are particularly risky to use. Tests show that these may have test voltages of up to 22.5 V. Clearly, this is a dangerous voltage to test the continuity of a network.

Reverting to the case where the test voltage lies between 700 mV and 2 V, it should be noted that, as said, diodes and transistors may come on, but in some cases that is an advantage. When, for instance, the base-emitter junction of a transistor is examined with a test voltage of 300 mV, the meter will invariably show ∞, which means very little. If the test voltage were 700 mV, the meter will show ∞ in one (reverse bias) direction, and a few hundred ohms in the other (forward bias) direction, indicating that the base-emitter junction is sound—see **Figure 1**.

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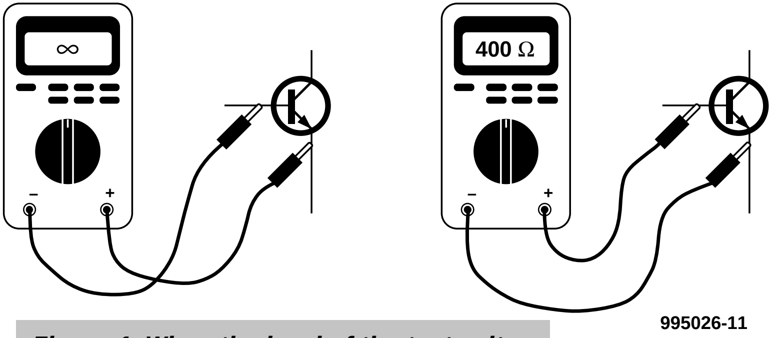

Figure 1. When the level of the test voltage is sufficiently high and the positive line is applied to the base of an n-p-n transistor, the resistance across the base-emitter junction is low. When a p-n-p transistor is checked, the polarity of the test voltage must, of course, be reversed.

Finally, note that in analogue multimeters the polarity of the test voltage is reversed with respect to the pin indication, that is, the positive test voltage is at the black (COM or earth) terminal or probe, while the negative test voltage is at the red terminal or probe. In digital multimeters, the positive test voltage is at the red terminal or probe and the negative test voltage at the black or COM terminal or probe.

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